Appendix 2
New Pages 1, 2, 5-9 and 14
of the Specification

INJECTOR OF COMPACT DESIGN FOR A COMMON RAIL INJECTION SYSTEM FOR INTERNAL COMBUSTION ENGINES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a 35 USC 371 application of PCT/DE 00/02825 filed on August 18, 2000.

BACKGROUND OF THE INVENTION

Field of the Invention

The invention relates to an injector for a common rail injection system for internal combustion engines, having a valve control chamber, defined by the end face of a nozzle needle, in which the fuel inlet takes place via an inlet throttle and the fuel outlet takes place via an outflow throttle, and there is a closing piston in the valve control chamber.

Description of the Prior Art

To reduce the structural length of conventional injectors, various efforts have been made, with the goal of constructing injectors in which the nozzle needle discharges directly into the valve control chamber, and no valve piston is necessary. From European Patent 0 426 205, an injector is known in which the nozzle needle discharges directly into the valve control chamber. Located in the valve control chamber are a control element and a closing piston. A disadvantage of this design is that the closing piston and the control element with an inlet throttle and outflow throttle are disposed in line with one another, so that despite the omission of the valve piston, the structural length of the injector is still comparatively great. Furthermore, the closing forces at the end of injection are relatively slight.

SUMMARY OF THE INVENTION

The object of the invention is to furnish an injector that is especially compact in structure and simple in design, and in which the closing forces at the end of injection are high.

According to the invention, this object is attained by an injector for a common rail injection system for internal combustion engines, having a valve control chamber, defined by the end face of a nozzle needle, in which the fuel inlet takes place via an inlet throttle and the fuel outlet takes place via an outflow throttle, and there is a closing piston, which has a greater diameter than the nozzle needle, in the valve control chamber.

This injector has the advantage that its structural length is especially short, since there is only one closing piston in the valve control chamber. Furthermore, in the injector of the invention the closing force at the end of injection is especially high, because the diameter of the closing piston is greater than the diameter of the nozzle needle. Finally, by reducing the number of components of the injector, a simple design of the injector has been achieved.

A variant of the injector of the invention provides that the closing piston is disposed between the inlet throttle and outflow throttle on one side and the nozzle needle on the other, so that the closing piston also takes on control tasks.

A variant provides that the inlet throttle and/or the outflow throttle is disposed in a housing of the injector, so that the dimensions of the injector are reduced still further.

BRIEF DESCRIPTION OF THE DRAWINGS

Further advantages and advantageous features of the invention can be learned from the ensuing description, taken with the drawings, in which:

Fig. 1 is a cross section through an injector according to the invention; and

Fig. 2 is an enlarged detail X of Fig. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In Fig. 1, an injector according to the invention is shown. Via a high-pressure connection stub 1, fuel 3 is carried via an inlet conduit 5 to an injection nozzle 7 and via an inlet throttle 9 into a valve control chamber 11. The valve control chamber 11 communicates with a fuel return 17 via an outflow throttle 13, which can be opened by a magnet valve 15. The fuel 3 is shown in Fig. 1 as a black area.

The valve control chamber 11 is defined by a nozzle needle 21. The nozzle needle 21 prevents the fuel 3, which is under pressure, from flowing into the combustion chamber, not shown, between injections. This is achieved by the provision that the nozzle needle 21 is pressed into a nozzle needle seat

22 and seals off the inlet conduit 5 from the combustion chamber, not shown.

The nozzle needle 21 has a cross-sectional change 23 from a larger diameter 25 to a smaller diameter 27. The nozzle needle 21 is guided with its larger diameter 25 in a housing 29. The cross-sectional change 23 defines a pressure chamber 31 of the injection nozzle 7.

In Fig. 2, an enlarged detail X of Fig. 1 of the injector of the invention is shown. In this view it can be seen that the valve control chamber 11 is defined by an end face 33 of the nozzle needle 21. A closing piston 34 is located in the valve control chamber 11 and has a first, larger bore 35 and a second, smaller throttle bore 36. The stroke of the closing piston 34 in the direction of the magnet valve 15 is limited by a stroke stop 37. A pin 38 with a conical tip that fits into a complimentary sealing seat 39 of the closing piston 34 protrudes from the end face 33 of the nozzle needle 21. Fig. 2 shows a state of the injector in which the closing piston 34 rests on the stroke stop 37, and the nozzle needle is seated on its nozzle needle seat 22, not shown in Fig. 2. In this position, there is a gap between the pin 38 and the sealing seat 39 of the closing piston 34, so the fuel 3, not shown in Fig. 2, can flow through the first bore 35 of the closing piston 34 into the part of the valve control chamber 11 located between the closing piston 34 and the nozzle needle 21.

When the outflow throttle 13 is closed, the hydraulic force acting on the end face 33 of the nozzle needle 21 is greater than the hydraulic force acting the cross-sectional change 23, because the end face 33 of the nozzle needle 21 is larger than the annular face of the area of the cross-sectional change 23. If the high-pressure pump, not shown, of the fuel injection system is not driven because the engine is at a stop, then a closing spring 40, acting on the end face 33 of the nozzle needle 21, presses the nozzle needle 21 against the nozzle needle seat 22 shown in Fig. 1 and thus closes the injection nozzle 7 or injector.

When the outflow throttle 13 is opened, which happens when a ball 41 of the magnet valve 15, not described in detail, is lifted from a ball seat 42, the pressure in the valve control chamber 11 drops. As a consequence, the hydraulic force acting on the end face 33 drops as well. As soon as this hydraulic force is less than the hydraulic force acting on the cross-sectional change area 23, the nozzle needle 21 moves in the direction of the closing piston 34, until the pin 38 rests on the sealing seat 39. As a result, the injection nozzle 7 shown in Fig. 1 is opened, and the fuel 3 is injected into the combustion chamber. The opening travel of the nozzle needle 21 is represented in Fig. 2 by the nozzle needle stroke "h".

The inlet throttle 9 prevents a complete pressure equalization between the inlet conduit 5 and the valve control

chamber 11. The opening speed of the nozzle needle 21 is determined by the difference in flow between the inlet throttle 9 and the outflow throttle 13.

This indirect triggering of the nozzle needle 21 via a hydraulic force booster system is necessary, because the forces required for rapid opening of the nozzle needle 21 cannot be generated directly with the magnet valve 15. The so-called "control quantity" required in addition to the fuel quantity injected into the combustion chamber reaches the fuel return 17 via the inlet throttle 9, the valve control chamber 11, and the outflow throttle 13. In addition to the control quantity, leakage also occurs at the nozzle needle guide. The control and leakage quantities can amount to up to 50 mm^3 per stroke. They are returned to the fuel tank, not shown, via the magnet valve 15.

To terminate the injection, the outflow throttle 13 is closed by the ball 41 of the magnet valve 15, in a known manner not explained in further detail. As a result of the closure of the outflow throttle 13, virtually the same rail pressure builds up again via the inlet throttle 9 in a portion 43 of the valve control chamber 11 that is defined by the closing piston 34 and the outflow throttle 13. This pressure exerts a hydraulic force on the nozzle needle 21 via the end face 45 of the closing piston 34 and via the pin 38 resting on the sealing seat 39. As soon as this hydraulic force exceeds the hydraulic force acting on the cross-sectional change area 23, the

nozzle needle 21 closes. Because the end face 45 of the closing piston is markedly larger in comparison to the annular face area of the cross-sectional change 23, the closing motion takes place very fast and with great force. Simultaneously with the closing motion, a small portion of the fuel, flowing into the portion 43 of the valve control chamber 11, flows through the throttle bore 36 into the valve control chamber 11 defined by the closing piston 34 and by the end face 33 of the nozzle needle 21. The closing motion takes place so fast that before a pressure equalization is reached, the nozzle needle 21 rests on the nozzle needle seat 22 again, and the injection is terminated. The closing speed of the nozzle needle 21 is determined essentially by the flow through the inlet throttle 9.

In order for the closing piston 34 to move to the outset position against the stroke stop 37 after the end of injection, the portion of the valve control chamber 11 defined by the closing piston 34 and the end face 33 of the nozzle needle 21 is filled with fuel through the throttle bore 36, while the closing spring 40 presses the closing piston 34 upward. It is also conceivable to omit the throttle bore 36 and to dimension the play of the closing piston 34 in the housing 29 in such a way that the fuel flows through the annular gap between the closing piston 34 and the housing 29. The second end face 47 of the closing piston 34 can also, as shown in Fig. 2, have a shoulder, which serves for instance to guide the closing spring 40.

The foregoing relates to a preferred exemplary embodiment of the invention, it being understood that other variants and embodiments thereof are possible within the spirit and scope of the invention, the latter being defined by the appended claims.